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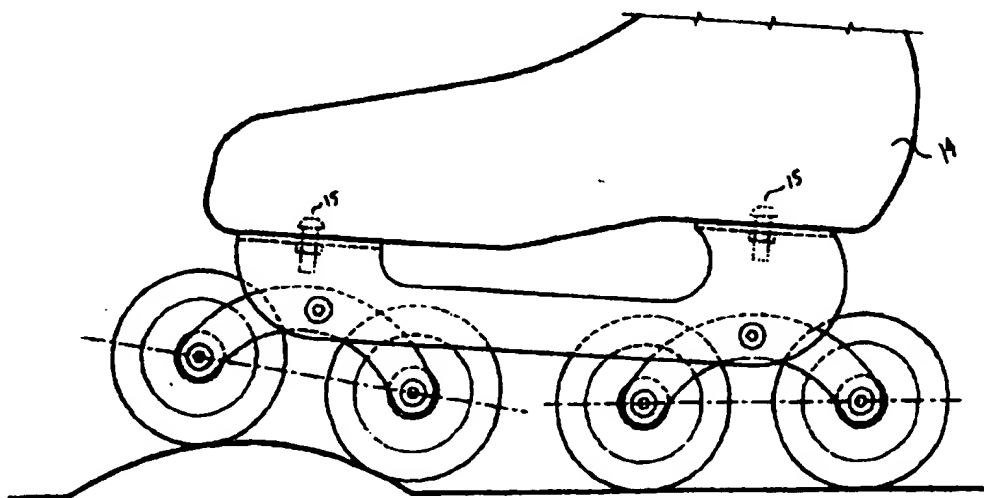
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(54) Title: AN IN-LINE SKATE WITH SUSPENSION



## (57) Abstract

A suspension system for an in-line roller skate includes wheels (8) carried by rocker assemblies (6, 20), the rocker assemblies are pivotally attached to a footplate of the skate to move vertically in relation to the footplate as the skate travels over uneven surfaces.

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**AN IN-LINE SKATE WITH SUSPENSION**Cross-Reference to Related Applications

5           This application is a continuation-in-part of pending  
United States Patent Application Serial No. 08/384,256,  
filed February 3, 1995.

Field of the Invention

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The present invention relates to in-line roller  
skating. Specifically, this invention concerns in-line  
roller skates that have suspension, thereby facilitating  
skating on imperfect or uneven surfaces and improving  
15 safety.

Background of the Invention

20 In-line skating is a form of recreation that has been  
practiced for more than two hundred years in various areas  
of the world. In recent times, it has evolved into a  
multi-faceted activity. Included among these activities  
are speed skating, hockey, cross-training, off-season  
training for skiing and ice-skating, dance, free-style,  
25 recreational, and so-called "street style" skating, which  
involves a number of stunts, e.g., curb and handrail  
"grinding," stair riding, ramp skating, jumping, and  
"stalling" (coming to an abrupt stop). For optimal  
performance, these activities require the maximum skate  
30 control possible.

Typically, an in-line skate consists of three basic  
components: a boot; a frame; and wheels. An in-line  
skating boot generally comprises one or more parts which  
serve to secure a foot of the skater to the remaining  
35 components of the skate. The boot is attached to the  
frame, typically through a "footplate," which may or may  
not be integrated into the boot. The frame holds the  
wheels. As inferred by the term "in-line" skate, the

wheels are aligned linearly front to rear in the direction of skate travel. See Figures 3 and 10. Wheels, available in a wide variety of sizes, compounds, densities, and designs (see, for example, U.S. Patent No. 5,048,848) are typically mounted vertically, although configurations where one or more wheels are tilted from vertical have been developed. Herein, wheels are numbered beginning with the wheel at the front of the skate.

Most in-line roller skating is done outdoors on a variety of different skating surfaces, including concrete and asphalt. Most skating surfaces are "uneven," in that imperfections exist in the surfaces, such as cracks, bumps, depressions, holes and the like. In addition, debris (e.g., sand, pebbles, sticks and twigs, trash, etc.) is often present on such surfaces. These imperfections make skating more fatiguing, reduce the amount of skate control, and can pose safety hazards to in-line skaters. Despite this, currently available in-line skates do not incorporate features to minimize the effects of imperfections in skating surfaces.

It is the object of this invention to provide in-line roller skates capable of minimizing the effects of imperfections in skating surfaces. To this end, in-line roller skates are provided which comprise a suspension system enabling the wheels of the skate to move in relation to the skate boot and/or frame in response to imperfections in the skating surface.

### Summary of the Invention

One aspect of the invention concerns an in-line roller skate with suspension wherein the skate comprises a footplate, a plurality of wheels aligned linearly front to rear, and a rocker assembly carrying at least two adjacent wheels. The rocker assembly is rotatably connected about an axis parallel to that of a wheel axle of a wheel carried by the rocker assembly to the footplate and enables at least one of the wheels carried thereby to move

vertically in a direction opposite that of at least one other wheel carried by the rocker assembly. The rocker assembly also comprises a spring and damper assembly mounted to an upper surface thereof. In one embodiment, such an in-line roller skate comprises at least two such rocker assemblies and each rocker assembly carries at least two wheels. In a preferred embodiment, such a skate has two such rocker assemblies, each of which carries two wheels.

Another aspect of the invention relates to an in-line roller skate with suspension, wherein the skate comprises a footplate and a plurality of wheels aligned linearly front to rear in a manner such that at least one wheel is capable of vertical displacement while the skate is in motion across a skating surface, wherein the vertical displacement results from rotation of a wheel carriage about an axis parallel to that of a wheel carried thereby and wherein the wheel carriage carrying the vertically displaced wheel is attached directly or indirectly to the footplate. In one embodiment, all of the wheels of the skate are capable of vertical displacement while the skate is in motion across a skating surface. In a preferred embodiment, each wheel is independently suspended, directly or indirectly, from the footplate by a swingarm assembly. In a particularly preferred embodiment, each of the swingarm assemblies suspending the wheels further comprise a spring and damper assembly. A spring and damper assembly assists in controlling the vertical displacement of each swingarm.

In another aspect of the invention, an in-line roller skate with suspension is provided wherein the skate comprises a footplate, at least one skate frame attached to the footplate, a plurality of wheels aligned linearly front to rear with all of the wheels being indirectly mounted to the footplate, and a rocker assembly carrying at least two adjacent wheels, with the rocker assembly being rotatably connected (about an axis parallel to that of a wheel axle) to a skate frame and enabling at least

one of the wheels carried thereby to move vertically in a direction opposite that of at least one other wheel carried by the rocker assembly. In one embodiment, such an in-line roller skate comprises at least two rocker  
5 assemblies and each rocker assembly carries at least two wheels. In a preferred embodiment, such a skate has two rocker assemblies, each of which carries two wheels. In a particularly preferred embodiment, at least one of the rocker assemblies comprises a spring and damper assembly,  
10 with the spring and damper assembly comprising at least one elastomeric polymer mounted to an upper surface of the rocker assembly being especially preferred. A representative embodiment of such a preferred in-line roller skate is one wherein the skate comprises a  
15 footplate, a skate frame attached to the footplate, four wheels aligned linearly front to rear, and two rocker assemblies, each rocker assembly carrying two of the wheels and having a spring and damper assembly mounted to an upper surface thereof, wherein each rocker assembly is  
20 rotatably connected about an axis parallel to that of a wheel axle of a wheel to the skate such that one wheel carried thereby (by the rocker assembly) is capable of moving vertically in a direction opposite that of the other wheel carried by the rocker assembly, as will occur  
25 when the skate traverses an uneven skating surface.

In yet another aspect of the invention, in-line roller skates with suspension are provided which comprise a footplate, at least one skate frame attached to the footplate, and a plurality of wheels aligned linearly  
30 front to rear. All of the wheels are mounted to the skate frame(s) in a manner such that at least one wheel is capable of vertical displacement while the skate is in motion across a skating surface, wherein the vertical displacement results from rotation about an axis parallel  
35 to that of a wheel axle of a wheel carried by a wheel carriage, attached directly or indirectly to the skate frame, carrying the vertically displaced wheel. In one embodiment of this aspect of the invention, all wheels of

the skate are carried in a skate frame suspended from the footplate by a swingarm assembly positioned to the front of the skate and rotatably attached to the rear of the footplate. In another embodiment of this aspect, all  
5 wheels are carried in a skate frame suspended from the footplate by two swingarm assemblies. In a preferred embodiment, the swingarm assemblies suspending the skate frame further comprise a spring and damper assembly to assist in controlling the vertical displacement of each  
10 swingarm.

In an embodiment of different aspects of the invention, the vertical displacement afforded by an in-line skate suspension system according to the invention for at least one wheel of the skate is greater than about  
15 0.05 inch while the skate is in motion across a skating surface. In another embodiment, the vertical displacement capable for at least one wheel is greater than about 0.10 inch while the skate is in motion across a skating surface. In another embodiment, the vertical displacement  
20 capable for at least one wheel is greater than about 0.125 inch while the skate is in motion across a skating surface.

An additional aspect of the invention concerns auxiliary or accessory systems which can be attached to  
25 in-line skates according to the invention. One such system is a brake system. In a preferred embodiment, the brake system comprises a brake pad mounted to the skate frame, such that a wheel carried by a rocker assembly can engage the brake pad upon tipping of the skate. Another  
30 such system is one which enables at least one wheel to rotate about an axis perpendicular to its axle. Another such system is a skate and/or frame protector that prevents direct and/or abrasive contacts or impacts to part or all of the footplate and/or skate frame. In a  
35 preferred embodiment, such a protector comprises two parallel members disposed opposite of one another, with the two members being spanned by a connector.

Brief Description of the Figures

Figure 1 is a side view of an in-line roller skate with suspension, the wheels of which are mounted in rocker assemblies (a type of wheel carriage according to the invention), each of which is rotatably attached to the skate frame such that the other rocker assembly can rotate in response to imperfections in the skating surface.

Figure 2 is a rear view of an in-line roller skate as depicted in Figure 1.

Figure 3 is an illustration from below of an in-line roller skate with suspension as depicted in Figures 1 and 2.

Figure 4 is an illustration of two rocker arms (6) spaced opposite and parallel one another by a bushing (3).

Figure 5 is a side view of an in-line roller skate according to the invention wherein two differently sized wheels are mounted in each of two rocker assemblies. The second and third skate wheels are smaller than the first and fourth wheels. In addition, the skate frame to which the rocker assemblies are mounted is contoured to facilitate certain street style skating maneuvers.

Figure 6 illustrates how the second and third wheels of the skate depicted in Figure 5 can be retracted upon rotation of the rocker assemblies.

Figure 7 is a side view of an in-line skate as depicted in Figures 1-3 that further comprises a brake system actuated by lifting the toe of the skate to engage a brake lever which in turn engages the third and fourth wheels of the skate.



Figure 8 depicts how an in-line skate as shown in Figures 1-3 reacts to an imperfection in the skating surface.

5        Figure 9 is an exploded view of the components which make up the rocker assemblies and skate frame of the in-line skate described in Example 1.

10       Figure 10 illustrates an assembled skate frame to which two rocker assemblies are mounted.

15       Figure 11 is a side view of an in-line roller skate with suspension, the wheels of which are mounted in rocker assemblies (a type of wheel carriage according to the invention). Each rocker assembly is rotatably attached to the skate frame such that each rocker assembly can rotate in response to imperfections in the skating surface. The axis of rotation of each rocker assembly is parallel to the axis of rotation of the axle of each of the four  
20       wheels of the skate. Vertical displacement of the wheels of each rocker assembly is controlled by a spring and damper assembly mounted to an upper surface of each rocker assembly.

25       Figure 12 is an exploded view of the components which make up a rocker assembly and skate frame of the in-line skate described in Example 1(b).

#### Detailed Description of the Invention

30

The present invention is based on the discovery of a new in-line roller skate design and configuration employing suspension. Suspension provides for increased stability and skate control, a smoother ride, enhanced  
35       safety, as well as making possible the development of new brakes and other accessory systems to improve in-line skate control and safety. Component numbers presented

below correspond to those listed in the accompanying figures.

### In-Line Roller Skate Suspension Systems

5

The present invention concerns in-line roller skates having a suspension system, also referred to as in-line skates with suspension. A suspension system according to the invention enables skates incorporating such a system to better maintain skate wheel-skating surface contact when the skate travels over an imperfect, uneven, rough, undulating, or otherwise unsmooth surface, as compared to a traditional in-line skate not having suspension. As those skilled in the art will appreciate upon reading the instant specification, various types of suspension systems can be developed for in-line roller skates. Alternatives include, but are not limited to, those employing wheel carriage assemblies and those employing one or more springs and/or dampers, as are described below. In addition, skates, component parts thereof, and auxiliary systems therefore can be manufactured from a combination of materials, as well.

According to the invention, an in-line roller skate with suspension refers to a skate wherein at least one wheel is capable of vertical displacement in relation to the footplate as the skate travels over an uneven surface. Such vertical displacement occurs in response to encountering some obstacle in or on a skating surface and is mediated by rotation of a skate component to which the wheel is mounted about an axis, typically the longitudinal axis of a shaft, trunnion, or bolt. The skate component that carries the wheel and rotates (or "hinges") about an axis (or "hinge pin") to provide vertical displacement of the wheel is a "wheel carriage," which, when a wheel is connected thereto, also includes the wheel. Typically, the axis of rotation for a wheel carriage parallels that for one or more of the wheel axles present in the skate. Representative examples of a wheel carriage include a

rocker, a rocker assembly, a swingarm, and a trunnion, all of which are capable of at least partial rotation about an axis.

Materials useful in the practice of the invention  
5 include metals, plastics and other polymers, ceramics, and composite materials. Preferred metals include steel, aluminum, magnesium, and alloys of such metals. Composite materials are those brought about by combining materials differing in composition or form on a macro scale for the  
10 purpose of obtaining specific characteristics and properties. The constituents retain their identity such that they can be physically identified and they exhibit an interface between one another. Composite materials include fibers such as carbon fibers in a synthetic  
15 matrix, such as a resin. Individual skate components, for instance skate frames, rocker assemblies, etc., can be manufactured from single pieces of material or be made by joining two or more parts. In a preferred embodiment, a skate boot is made of a hard, resilient plastic and the  
20 skate frame (if present) and/or suspension system components are metal, preferably steel (or an alloy thereof) or aluminum. Auxiliary systems, e.g., brakes, "grind" plates, etc., may also be manufactured from these or other suitable materials.

25

(i) In-Line Skate Suspension Based on Rocker Assemblies.

One aspect of the invention concerns an in-line  
30 roller skate comprising a suspension system based on the use of one or more rocker assemblies. As used herein, a "rocker" refers to a component made of one or more parts to which wheels can be attached and which is designed to rotate about an axis parallel to the rotational axis of a  
35 wheel axle suspended therefrom. When wheels are attached to the rocker, the assemblage is referred to as a "rocker assembly." The rocker or rocker assembly is attached to an in-line skate preferably via the skate frame or

footplate. In order to provide suspension capability, the rocker must be capable of movement so that wheels attached thereto can move or be displaced in relation to the footplate as the skate travels over an uneven surface, thereby "smoothing" the ride from the skater's perspective. Additionally, skates incorporating suspension systems enable skate wheels to be kept in contact with the skating surface as compared to a conventional in-line skate, e.g., a Rollerblade® Lightning®, particularly over rough or uneven surfaces.

A rocker according to the invention typically comprises a rocker arm to which at least two wheels can be attached. The arm can have many different shapes. Various embodiments include arms which, when viewed from the side and positioned as would occur in a functional skate, are crescent shaped, linear, curved upward or downward at either or both ends, etc. In a preferred embodiment, the arm is manufactured to have a shape wherein the wheel attachment points are below the location at which the arm is attached to the footplate or skate frame.

Typically, wheels are affixed to the arm by a retainer and axle. For instance, when a bolt is used as the retainer, it extends through an opening in the arm intended for the shank portion of the bolt to be passed through. It is inserted into an axle with a female portion threaded to accept the bolt. The other end of the axle has a retainer to keep the wheel which rotates about the axle from coming off after attachment to the arm. Alternatively, the arm will have an integrated axle for each wheel, with the wheels being retained by a nut, bolt, or both retainer at the axle end opposite the that attached to the arm. Independent of how the wheels are attached to the arm and somewhere between the most distal wheel attachment locations, a component is located which enables the rocker assembly to be attached to the footplate or skate frame in a manner that allows one of the wheels carried by the rocker assembly to be displaced

towards the bottom of footplate and another wheel carried thereby to be displaced in the opposite direction. The component enabling attachment of the rocker to the footplate or frame typically consists of a shaft, bolt or trunnion about which the rocker assembly can rotate. In one embodiment, the component enabling attachment of the rocker or rocker assembly to the footplate or skate frame is itself not capable of vertical displacement or translation when configured in a functional skate.

10 In one embodiment of this aspect of the invention, a rocker comprises two arms between which two or more wheels can be mounted. Preferably, each arm has the same shape and the point about which the arms are designed to rotate when attached to a frame or skate is above the axis about which the wheels roll when wheels are mounted between the arms. In a preferred embodiment of this aspect of the invention, the rocker is manufactured as a single component which has an upper surface, wherein the upper surface is positioned above the bore, the centerline of which the component will be capable of rotation about upon attachment to the footplate or skate frame by a suitable fastener or hinge pin.

20 In one embodiment, one or more spring and damper assemblies are attached to the upper surface of the rocker. In response to wheel displacement, the spring and damper assembly is compressed against a surface opposite the spring and damper assembly, typically a portion of the underside of the footplate (or component attached thereto) or the underside of the top of the skate frame, if the frame is so designed. As those in the art will appreciate, the upper surface of the rocker to which the spring and damper assemblies are attached need not be flat, or horizontal, as depicted in Figures 11 and 12. Similarly, the surface against which the spring and damper assemblies are to be compressed need not be flat, or horizontal.

35 In an alternative embodiment, the spring and damper assembly may be mounted to the skate frame or footplate

and be compressed against the upper surface of the rocker. In yet another alternative embodiment, the spring and damper assembly may be split between the upper portion of the rocker and underside of the footplate or top of the frame. For example, as depicted for the two part spring and damper assembly for the rocker assembly nearest the toe of the skate shown in Figure 11, one spring and damper can be mounted to the upper surface of the rocker, and the other spring and damper to underside of the top of the skate frame.

In yet another embodiment, vertical displacement of the rocker assembly can be controlled by a horizontally mounted spring and damper assembly. Under conditions of wheel displacement, the spring and damper assembly is engaged by a component such as a vertically mounted tongue.

An in-line skate employing a rocker-based suspension system comprises one or more rocker assemblies. As will be appreciated, numerous configurations are possible. While preferable, it is not required that all skate wheels be carried in one or more rocker assemblies. One or more wheels may be mounted so that no vertical displacement of the wheel(s) relative to the footplate occurs in response to encountering an imperfection, for example, a bump, on the skating surface. For instance, an in-line skate comprising three wheels, only two of which are carried in a wheel carriage, can be manufactured. In such a configuration, it is preferred that the wheel carriage carry the first and second wheels. The third wheel is mounted in such a way that the distance between the axis about which the axle of the third wheel rotates remains fixed in relation to a reference point on the skate frame, boot, or footplate (e.g., the bottom of the footplate directly above that wheel) upon traversing an uneven skating surface. In contrast, the axis of the axle of either or both of the first and second wheels is displaced up and down ("vertically displaced") in relation to the

bottom of the footplate (or another convenient reference point) as the skate moves over the uneven skating surface.

The amount of vertical displacement depends on numerous factors, including the size (height, width and/or  
5 depth) of the surface imperfection and the inherent maximal amount of wheel travel (distance of positive vertical displacement) provided by the particular wheel carriage design. Vertical displacement is measured in terms of positive and negative displacement. Displacement  
10 is measured by the vertical distance the axle for a given wheel moves in relation to a reference point, typically the bottom or underside of the footplate. Zero or no displacement for a particular wheel refers to that displacement observed when the skate travels across or it  
15 at rest on a completely flat, smooth surface. A wheel is positively displaced when the axle moves closer to the bottom of the footplate, i.e., the gap between the top of the wheel and the bottom of the footplate narrows, when the bottom of the footplate is used as the reference  
20 point. A wheel is negatively displaced when the axle (and wheel) moves further from the reference point than when at rest on or traveling across a flat, smooth surface.

The amount of wheel travel inherent in a given wheel carriage, e.g., a rocker assembly, depends on many  
25 factors. Some of these factors are the size of the wheels employed, the particular wheel (i.e., first, second, etc.) in the wheel carriage being considered, the size and shape of the component(s) to which the wheels are attached, the location in the wheel carriage of the point about which  
30 the assembly rotates to provide wheel displacement, the spring and damper assembly (if any) employed, and the presence of a block or stop to limit wheel travel. Asymmetrical rocker geometry, where the pivot point (or rotational axis) about which the rocker rotates is offset  
35 or not equidistant from the most distal wheel attachment locations of that rocker, can also be produced. For instance, the rotational axis of an asymmetrical rocker

can be nearer the leading wheel of a rocker assembly carrying two wheels.

In addition, each of the wheels in a given rocker assembly may have different positive and negative displacement maximums. For instance, in a rocker assembly carrying two wheels, one wheel may have a maximal positive displacement  $D(+)_\text{max}$  of 1.0 in. and a maximal negative displacement  $D(-)_\text{max}$  of 0.75 in., while the other wheel has a  $D(+)_\text{max}$  of 0.5 in. and a  $D(-)_\text{max}$  of 0.5 in. Additionally, total vertical displacements (the sum of  $D(+)$  and  $D(-)$ ) for a given wheel in a rocker assembly according to the invention will generally not exceed about 3.0 in. (although greater displacements are possible and fall within the scope of the invention) and are preferably less than about 2.0 in., with total vertical displacements of less than about 1.5 in. but more than about 0.33 in. being particularly preferred.

In one embodiment of this aspect of the invention, the leading wheel in the wheel carriage (that wheel nearest the front or toe of the skate) is partially or totally prevented from a negative displacement by a stop, block, spring, or other component. This can prevent the leading wheel from becoming lodged in a depression or other imperfection in the skating surface. In a preferred embodiment, negative wheel displacement of one wheel carried by a rocker assembly, absent a wheel-displacing load placed on the wheel of the rocker assembly (such as may occur during normal skating activities when the skate is lifted from the ground by the skater during a return stroke), is kept to a minimum or eliminated by the presence of a spring and damper assembly. Under no-load conditions, negative wheel displacement can be minimized, the actual amount of displacement being controlled by the distance, if any, between the rocker assembly and its corresponding spring and damper assembly (when the damper is attached to the footplate or skate frame) or spring and damper assembly and the footplate or skate frame, as occurs when the spring and damper assembly is mounted to



the rocker assembly, if there is no such distance, by the stiffness, hardness, or density of the spring portion of the spring and damper assembly. Asymmetrical rocker designs can also influence the maximum positive or  
5 negative vertical displacement of a given wheel.

A preferred embodiment of the invention is an in-line roller skate comprising two rocker assemblies, each of which carries two wheels. The rocker assemblies can be mounted directly to the footplate by way of a shaft about  
10 which the rocker assemblies can rotate. Preferably, the shaft or other means by which a rocker assembly is rotatably attached to the footplate is not itself capable of vertical displacement, such as in an elongated slot. Additionally, the vertical displacement of such a rocker  
15 assembly is controlled by a spring and damper assembly. Alternatively, a bolt or trunnion can be used to attach the rocker assemblies to the footplate. In a particularly preferred embodiment, the rocker assemblies can also be attached indirectly to the footplate by way of attaching  
20 them to the skate frame in a manner that allows a "rockering" action of the wheels in relation to other parts of the skate as it travels over uneven surfaces. It should be noted that footplates are often molded from plastic or other polymers and are often integrated into  
25 skate boots. However, footplates can be fabricated from other materials and need not be integrated into the boot. As is apparent from this invention, footplates can also be manufactured to directly accept suspension systems according to the invention.

30 The wheels carried in the rocker assemblies need not each be of the same diameter. A variety of wheel sizes are commercially available, ranging from 46 - 80 mm, although other sizes can be readily manufactured. In one embodiment of the invention, the center two wheels (wheels  
35 2 and 3) of a four wheel skate are of a smaller diameter than the leading and trailing wheels (wheels 1 and 4, respectively, of a four wheel in-line skate). Such a configuration facilitates many "street style" skating

maneuvers. Alternatively, for situations where maximal maneuverability is desired, the leading and trailing can be of a smaller diameter as compared to wheels 2 and 3. By substantially limiting or eliminating the ability of the rocker assemblies to be vertically displaced and configuring the skate such that only wheels 2 and 3 will contact a smooth skating surface under normal conditions, maneuverability may be enhanced. Vertical displacement of rocker assemblies can be substantially limited or eliminated by a variety of retainers, including pins, bolts, etc., which extend through one or both sides of a skate frame to engage a rocker assembly. For skates having no frame, the rocker assemblies can be similarly prevented from vertical displacement by a variety of configurations.

Another embodiment of this aspect of the invention relates to the distance between the rotational axes of rocker assemblies when more than one such assembly is included in the skate, be they attached to skate directly via the footplate or indirectly through one or more skate frames. The greater the distance between the axes, the greater the skate stability. In addition, the closer the axes are located to either the front or rear of the skate, the lower the tendency of the skate to be unintentionally tipped forward or backward during skating.

In-line skates according to the invention may also include one or more wheels with "steering" or "tracking" capability. Such capability can be provided by mounting a wheel or wheel carriage (carrying a wheel) to the skate about a vertically positioned shaft about which the wheel carriage can rotate. As used throughout this invention, "rotation" with respect to components of the suspension and accessory systems described does not require a 360 degree revolution. A lesser degree of rotation, even as little as one degree or less, although generally more than 5 - 10 degrees, is all that is required. In such steering or tracking embodiments, those wheels with steering or tracking capability may not always be "in line" with other

wheels of the skate. Such a configuration can provide for enhanced maneuverability and reduce the friction between the skate wheel(s) and skating surface during cornering, etc., reducing the speed or momentum that would otherwise be lost during the particular maneuver. The range of rotation permitted for the wheel(s) or wheel carriage may be limited, for example, to prevent a wheel or wheels from becoming oriented perpendicular to the direction of skate travel, such as may occur should the skater jump or otherwise lift the skate off of the skating surface.

In an alternative embodiment, skate maneuverability can be enhanced and frictional losses reduced by manufacturing skate frames and/or wheel carriages which can be made to flex, bend, deflect or otherwise distort in relation to the direction of skate travel upon application of sufficient force. A similar approach is employed in the manufacture of snow skis. When traveling in a straight line, the skate frame and/or wheel assembly is linear. However, upon turning, the frame and/or one or more wheel assemblies flex to form a slight arc. The amount of deformation from linear depends on many factors, including but not limited to the force applied to the component, the material type(s) and thickness(es) employed in the frame or rocker(s), etc. In-line skates according to the invention which comprise skate frames can also be made to better deflect or distort by splitting the frame into two or more components, each of which is rigidly attached to the footplate. In this way, the skate can be made to more easily bend into a slight arc during cornering or turning.

(ii) In-Line Skate Suspension Based on Springs.

Another aspect of the invention concerns in-line roller skates wherein the suspension system utilizes one or more springs and/or shocks. As used herein, a "spring" is a device that deflects when a force is applied to it and thereafter returns to its original shape. The amount

of deflection varies with the force applied and the spring's design, material, and size, among other things. Springs generally are coils, leaves, or torsion bars and are typically manufactured from high quality material, such as chrome vanadium steel, chrome moly steel, and various high strength composite materials. Springs useful in the practice of the present invention can also be made of resilient materials such as rubber and other suitable elastomeric polymers.

"Shocks," or "dampers," are devices which, among other things, control the rate at which the corresponding spring compresses in reaction to upsets, dampen the release of energy stored in a compressed spring, and dampen unwanted spring vibration. Generally, shocks useful in the practice of the present invention are hydraulic, gas, oil/gas, or made from one or more elastomeric polymers. Combinations of different damper types can also be practiced in the context of the invention.

Together, springs and shocks work to help control vertical displacement of wheels, which is also affected by the amount of wheel travel allowed by the suspension system employed. Springs and dampers can be configured in a variety of ways. Typical configurations useful in the practice of the present invention include "coil over damper" arrangements or a spring separated from its corresponding damper. A preferred embodiment of this aspect of the invention comprises a spring and damper assembly wherein both the spring and damper components are made of one or more types of elastomeric polymers ("elastopolymers"), such as polyurethane elastopolymers. In fact, a single elastomeric polymer unit can act as both a spring and damper. Different elastopolymers can be combined in a spring and damper assembly to adjust ride stiffness and rebound performance. The elastopolymers so combined may be separated from one another by compression washers or similar structures. Such spring and damper assemblies can be packaged in a cartridge for easy

handling and installation or be arranged in a simple stack. Different spring and damper assemblies can be employed, depending upon factors including the amount of sprung and unsprung weight to be acted upon, the number of  
5 wheels that are suspended from the skate, and the method of suspension, i.e., by rocker assembly, independent suspension, etc.

In one embodiment, a spring and damper assembly is used in connection with an in-line skate suspension system  
10 based on rocker assemblies. One or more spring and damper assemblies can be attached to a rocker assembly to control vertical displacement. In a preferred embodiment, one spring and damper assembly is attached to a rocker assembly comprising two rocker arms at a point behind the  
15 rotational axis (or pivot point) of the rocker. For attachment, a suitable piece of material is typically affixed to (or between) the rocker arm(s) and one end of the spring and damper assembly is attached thereto by way of a shaft, pin, or other element about which the assembly  
20 can move. The opposite end of the spring and damper assembly is similarly attached to the footplate.

Another embodiment of this aspect of the invention concerns skate frames that are suspended from the footplate by a swingarm and one or more spring and damper  
25 assemblies. As used herein, a "swingarm" comprises one or more pieces, or "arms," which span from a wheel of skate frame to the footplate. One end of the swingarm is attached to the footplate so that it can rotate, or "swing" about a shaft, pin, trunnion, or similar  
30 connector, while the other is similarly attached to the skate frame or wheel. An appropriate spring and damper assembly should also be included.

In one preferred embodiment, the front of the skate frame is suspended by a swingarm assembly, which also  
35 comprises a spring and damper assembly. The rear of the skate frame is attached to the footplate by way of a shaft, bolt or trunnion. Thus, the amount of wheel travel diminishes for each wheel moving from front to rear. A

spring and damper assembly is also included. As with any suspension system described herein, the maximum amount of positive vertical displacement is a factor of skate design, the spring and damper assembly employed, etc. To prevent damage to the swingarm assembly, it is preferable to that the frame attachment location of the swingarm be forward that of the footplate attachment location.

In another embodiment, a skate frame is suspended from the skate at both ends using a swingarm assembly. To prevent damage to the rear swingarm, it can be mounted in an orientation opposite that of the swingarm attached to the front of the skate frame, i.e., its pick-up point on the footplate is forward that of the skate frame attachment point.

In yet another of the many embodiments of this aspect of the invention, an in-line skate having at least one wheel independently suspended can be made. As used herein, "independent" suspension refers to a skate where one or more wheels can move vertically independently of any other wheel. In a preferred embodiment, each wheel is independently suspended. Such an all wheel independent suspension can be provided by suspending each wheel of the skate from the footplate or frame by a swingarm and spring and damper assembly, as described in Example 2, below.

#### (iii) Skate and/or Frame Protectors

Another aspect of the present invention relates to in-line skate and/or frame protectors and methods for using such protectors to prevent damaging impacts to and/or abrasive contacts with a skate and/or frame. As those in the art appreciate, in-line skates and/or frames and wheels (or "rollers"), or portions thereof, especially those portions between the wheels, are potentially exposed to impacts with various surfaces. In particular types of skating, e.g., street style skating, the potential for such impacts is markedly increased, and when it occurs

repeatedly, and/or when it occurs against an abrasive surface, the skate and/or frame can be damaged.

In light of these hazards, different approaches can be taken to prevent damaging impacts or abrasive surface contacts with the skate frame. See U.S.S.N. 08/155,281 (filed November 22, 1993), hereby incorporated by reference, for a description of frame protectors which can be adapted to skates according to the invention.

As used in this invention, a skate or frame protector prevents direct impact to or contact with an underside portion of a skate or frame. The underside of a skate or frame is that side, edge, or surface closest to (and most cases, parallel to) the ground. An underside portion of a skate frame is understood to range from the entire underside of the skate or frame (exclusive of those areas required for wheel protrusion, etc.), the entire underside of either of an inboard side (the side on the same side as the instep of a skater's foot) or an outboard side of a frame, to as little as 0.01 in. (inch) of either of the undersides of an inboard or outboard side of a frame. In preferred embodiments, at least 0.1 in., 0.2 in., 0.3 in., 0.375 in., 0.5 in., 0.75 in., 1.0 in., 1.5 in., 2.0 in., 2.5 in., 3.0 in., 3.5 in., 4.0 in., 4.5 in., 5.0 in., 5.5 in., or 6.0 in. of an underside portion of the skate frame or more are protected by the skate frame protector.

Skate frame protectors can be mounted to one or, in a preferred embodiment of this aspect, to both sides of a skate frame. In addition, a skate frame protector may be mounted on either the interior surface or exterior surface of the inboard, outboard, or both sides of the skate frame. In one embodiment, the skate frame protector is mounted to the exterior surface of either the inboard or outboard side of the skate frame. In another embodiment, a skate frame protector spans from the inboard side to the outboard side of the frame. Such a protector may be mounted to the exterior surface of the two sides, to their interior surfaces, or to the interior surface of one side and the exterior of the other side. For instance, a skate

frame protector can be produced which mounts between the inboard and outboard sides of the skate frame. Such a protector may be a solid piece of material or may have a configuration such as an upright or inverted "U" shape when mounted to the skate frame. Protectors can also be designed for skates according to the invention which do not have frames, but which have wheels mounted directly to the footplate.

Skate or frame protectors can be mounted to the skate frame using a variety of fasteners, bonding agents (e.g., adhesives, epoxies, glues, and other chemical agents capable of bonding a skate frame protector to a skate frame) or mechanical means. Representative fasteners include, but are not limited to, various types of bolts, screws, etc. The use of fasteners affords the possibility of later removal of the skate frame protector, such as to facilitate wheel service or replacement, mounting on another frame, etc. Similarly, mechanical systems, such as slots, slides, snaps, clips, etc., can also be used.

Also envisioned is the use of a skate frame protector comprised of more than one component. The various components of such a skate frame protector may all be permanently affixed, removable, or a combination thereof. For example, permanent skate frame protectors can be attached to areas of a frame less susceptible to harmful impacts and/or abrasive contacts than other regions of the frame. As the center regions of a skate or frame (such as the area between wheels 2 and 3 on a 4 wheel skate) typically are exposed to more such impacts and abrasive contacts, in terms of number and severity, it may be preferable that the protective means in this region be easily detachable for purposes of maintenance and/or replacement. In addition, the skate or frame protector may comprise multiple components, and such components may be made of different materials. For instance, a detachable hard plastic insert can be designed for attachment to that part of the skate frame protector intended for contact or abrasion.



Skate or frame protectors can be comprised any impact- or abrasion-resistant material. In one embodiment, such materials will be more resistant to damage than the material comprising the skate frame to which the protector(s) is to be mounted.

Lightweight, readily machined materials are preferably utilized. Such materials include metals, hard plastics, composite materials, i.e., fiberglass, carbon fiber, etc., in combination with an appropriate resin, and ceramics and can be manufactured to mount to the variety of skate frame configurations available. In addition, the inboard and/or outboard sides of the skate frame may themselves be contoured to varying degrees. See Figure 5. The present invention contemplates manufacture and/or machining of the disclosed protectors so as to conform, as closely as is necessary to achieve proper attachment, to the contour(s) of a given skate frame.

Skate or frame protectors, when mounted on a skate or frame, should at least mount flush or even with the lowest surface of the underside of the skate or frame to which the skate frame protector is attached. Preferably, such protectors will protrude beyond the surface of the protected underside of a frame so as to prevent wear and/or damage. However, such protrusion should not be so great so as to cause contact with normal skating surfaces under normal skating conditions. In addition, such protrusion should not interfere with a skater's ability to tip or otherwise alter the angle of inclination of the skate. As such interference is affected by factors including the angle of skate inclination and length of the protrusion, skate frame protectors useful with skate according to this invention that extend well beyond the underside of a frame should be designed to account for such factors. One such design is presented in Example 4.

In addition, such protectors protruding below the underside of the frame may also overlap and thus shield the inboard and/or outboard side of the frame. Such overlap or shielding may completely span the underside of

the frame. Additionally, skate frame protectors that extend beyond the underside of the frame may be contoured on that surface which is exposed to various contacts. Such contours include, but are not limited to, concave shapes.

(iv) Brake Systems

As those in the art will appreciate, among the accessory systems suitable for inclusion on in-line roller skates according to the invention are brakes, braking mechanisms, or other devices useful in slowing or stopping the skates, collectively referred to hereafter as "brakes." Furthermore, skates according to the invention enable the design and manufacture of a variety of previously unknown skate braking mechanisms. Additionally, new and conventional brake mechanisms can be included together on a single in-line skate according to the invention. Representative examples of new brakes include those employing a lever action to engage wheels of an in-line skate having a rocker assembly-based suspension system, as described below in Example 4. Hybrid brakes employing new and conventional brake mechanisms may also be employed. In addition, when rocker assemblies are mounted to a skate frame, a brake mechanism can be configured to engage one of the wheels of a rocker assembly upon tilting of the boot. For instance, a brake for the front wheel of the forward rocker assembly of a four wheel, two rocker assembly skate can be attached to the skate frame in front of the rocker assembly. When the skate is tilted forward sufficiently, the front wheel (wheel 1) engages the brake. Preferably, the surface of the brake will be contoured so as to better engage the wheel. A similar arrangement, i.e., a brake attached to the skate frame, can be made for the rear wheel of the rear rocker (wheel 4). In a preferred embodiment, each skate of a pair of in-line skates according to the invention will have a front and rear brake integrated into

the skate frame. That portion of the brake that contacts its corresponding wheel is preferably moveable, so that it can be replaced after becoming worn.

Many different in-line skate braking systems are known in the art and include caliper-based brakes and the GRIP In-Line Speed Control System™ (Canstar Sports USA, Swanton, VT). These and similar skate brakes are actuated by levers held in the skater's hands. However, because the present invention provides in-line skate configurations allowing the skater to tilt or otherwise control the position of the skate boot and/or footplate in relation to the wheels, i.e., the boot can be tilted forward or rearward and at least two wheels will remain in contact with the skating surface, a "hands-free" actuating systems for these brakes can be employed. For instance, a modified GRIP system can be employed wherein braking action results from the skater tilting a skate carrying wheels equipped with the brake mechanism in the rearmost of two wheel carriage assemblies. Upon lifting the toe of the skate, the actuating cable, extending from a position nearer the toe of the skate to each brake, causes the caliper mounted to each wheel to engage its corresponding drum. To avoid brake actuation due to imperfections in the skating surface, vertical displacement, particularly negative or downward displacement, of one or more wheels equipped with such a system may be limited by an appropriate mechanism.

Many other conventional in-line roller skate brakes may also be used in conjunction with the skates of the present invention.

The following examples are presented to illustrate the practice of the present invention. They are not to be construed as limiting the scope of the invention in any manner.

## Example 1

*In-Line Skate with Wheel Carriage Suspension*

5           The following example describes two four wheel in-line roller skates according to the invention wherein each skate has two rocker assemblies rotatably mounted in a skate frame. Each rocker assembly carries two wheels. In part (a), the rocker assemblies are comprised of two  
10 rocker arms and no spring and damper assembly is included in the skates. In contrast, the skate described in part (b) comprises single piece rocker assemblies and a spring and damper assembly mounted to each rocker assembly.

15           (a) In-line skate with rocker assemblies

          An in-line skate with wheel carriage suspension according to this invention was manufactured as follows: A template was used to sketch the various components of the skate frame onto a sheet of 0.125 inch thick cold  
20 rolled steel. Specifically, two templates were employed in this manner. The first template represented the shape of each of the two sides of the skate frame (11). The second template was employed to make multiple copies of the rocker arm (6) for the skates. The templates were  
25 used to mark the sheet of steel. Each of the pieces was then cut from the steel using a jig saw equipped with a suitable metal cutting blade. Holes of appropriate diameter were then drilled in each of the pieces, as  
30 indicated on the templates, to provide openings through which bolts could be inserted in the skate frame sides (11) and rocker arms (6). The excised pieces were then deburred and sanded.

          Each skate frame was made from two identical skate  
35 frame sides (the first and second skate frame members). One such member became the inboard side of the skate frame, the other member the outboard side, depending upon whether the skate frame, once assembled, was attached to a

skate boot for a right or left foot. To construct the skate frame, a connector (12) was welded to a first skate frame member at the heel. Subsequently, a second connector was welded to the first skate frame member at the toe. The second skate frame member was then welded opposite and parallel to the first skate frame member at the open end of both connectors.

Each rocker assembly was made using two rocker arms. Each rocker assembly was designed to carry two wheels (8) (as used herein, a "wheel" includes a suitable bearing (7) to allow the wheel to rotate about an axle (9)). Each of four rocker assemblies was made by attaching two 76 mm wheels between two wheel carriage arms, as shown in FIG. 9. The wheels were spaced from the rocker arms by an appropriately sized spacer (10) through which a threaded axle bolt (1) extended. The two axle bolts for each wheel were tightened to an appropriate torque.

Two rocker assemblies were then attached to each of the two skate frames by way of two 1/4-20 button head cap screws (13; "cap screws") screwed into a threaded coupling (2) positioned in a steel bushing (3) having an inner diameter slightly larger than outer diameter of the threaded coupling and having lengths equivalent to the distance between the inside edges of the two rocker arms carrying the wheels in a rocker assembly. The cap screws were tightened to an appropriate torque. The steel bushing helps to maintain a uniform distance between the inner surfaces of the two rocker arms in each rocker assembly. To prevent binding of the rocker assembly against the inner surface of either or both inner surfaces of the sides of the skate frame during action of the suspension system, a spacing system comprised of a nylon washer(4)-metal washer(5)-nylon washer(4) (see Figure 9) was used.

After the rocker assemblies were attached to the skate frames, each of the two frames was affixed to one of a pair of in-line skate boots. A completely assembled skate frame made as described in this example is depicted

in Figure 10. The frames were affixed by bolting each frame to a boot (14) by way of two mounting bolts (15) protruding through the footplate of the boot. Each bolt was inserted through the a mounting hole in each connector (12) of the frame. Nuts were then tightened to each bolt, thereby affixing the frames to the boots.

A second skate frame with suspension was then fashioned in the same manner as the first and attached to a boot fitting a right foot. The pair of skates was then tested on a variety of uneven or "imperfect," skating surfaces. The skates performed as anticipated, in that the suspension system "smoothed out" imperfections in the skating surface, as compared to a conventional four wheel in-line skate lacking suspension when ridden over the same surface. The skates according to the invention also maintained greater wheel contact with the skating surface as compared to the conventional skate.

(b) In-line skate with rocker and spring and damper assemblies

A four wheel in-line roller skate according to the invention which comprises a skate frame to which two single piece rocker assemblies are rotatably mounted, wherein a spring and damper assembly comprised of two elastomeric polymers is mounted to each rocker assembly, is made as follows: Each of two rocker assemblies were made by manufacturing a single piece bogey (20) from a piece of aircraft quality aluminum. Each bogey was made to have four arms. The distal ends of each bogey arm were drilled to allow a threaded axle bolt to be inserted. Each of these holes was beveled to allow a tapered axle bolt to flush mount to the outer surface of the bogey. In addition, the upper surface (21) of each bogey was made flat and parallel but elevated above the plane intersecting the centerline of each axle bolt hole in the bogey arms. The upper surface was then drilled to accept two short spring and damper retaining pins (22), which

were then inserted in the upper surface of the bogey. Each spring and damper retaining pin, once mounted in the upper surface of the bogey, protruded a sufficient amount to retain a cylindrical elastomeric spring and damper polymer of about 0.5 inch in height but not so far as to limit the compression of the elastomeric polymer. Individual elastomeric polymers (23) having a central bore (26) were then fitted over each retaining pin (22). Two wheels were then mounted to each bogey using axle bolts, washers, bearings and axles as described above. The resulting rocker assemblies were then ready for attachment to the skate frame.

A single piece skate frame having two parallel opposed sides evenly spaced along their lengths to accept two rocker assemblies and wheels carried thereby was manufactured from a single piece of aircraft quality aluminum. The frame included a shelf (18) below the rear portion of the frame intended for attachment to the heel portion (19) of the boot. The profile of such a skate frame is depicted in Figure 11. A total of four holes, two on each side of the frame, were then bored to accept screws (13) to rotatably mount each rocker assembly in the skate frame. The frame was then mounted to the footplate of a skate boot. Each of two rocker assemblies was then mounted inside the skate frame using appropriate hardware. This process was repeated to generate the components needed to make the other skate of the skate pair.

## Example 2

30

### *In-Line Skate with Biased Suspension*

In this example, three alternate in-line roller skates with suspension are described wherein the skate wheels are suspended directly or indirectly using at least one spring and damper.

A. Independent Suspension.

An in-line roller skate according to the invention is constructed wherein each wheel is independently suspended using a swingarm assembly to carry the wheel and a coil  
5 over shock to control suspension travel.

Two swingarm assemblies are attached to the skate footplate by way of a rotatable common shaft inserted through a swingarm attachment point. Each swingarm assembly is constructed by machining two swingarm arms  
10 from a suitable material, such as cold rolled steel. Holes for the axle bolt and common shaft opening are then drilled in each arm. The pieces are then deburred and sanded. For the trailing swingarm assembly, each arm is stamped to introduce an offset sufficient to enable the  
15 assembly to move without contacting the leading swingarm assembly. The arms comprising each swingarm are then held in an appropriate jig (separating the arms in parallel by the appropriate distance) and welded to a suitably sized, stamped coil over shock lower mount. A single suitable  
20 spring and damper assembly (preferably a cartridge containing elastomeric polymers) is then attached via its lower mount to each swing arm. The trailing and leading swingarm assemblies are then mounted to the skate footplate using the threaded common shaft and appropriate  
25 nuts. Each spring and damper assembly is then attached to the footplate using appropriate hardware. A 76 mm wheel is then mounted to each swingarm as described in Example 1.

To complete the skate, similar leading and trailing  
30 swingarm assemblies and wheels are then mounted to the rear swingarm attachment point on the footplate. As those in the art will appreciate, numerous variations, modifications, and additions can be made to this basic configuration. These include brakes, "grind" plates and  
35 other protective frames, etc.



B. Skate frames suspended with one or more springs.

In-line roller skates according to the invention can also be manufactured wherein the wheels are carried in a skate frame. In contrast to conventional in-line roller  
5 skates, the frames described herein are capable of moving in relation to the footplate of the skate due to the suspension system employed. Specifically, two suspended skate frames are described, although others will be evident upon reading these descriptions.

10 i. Pivoting frame - one swingarm.

In one embodiment of this skate or frame type, the rear of the frame is attached to the footplate via a shaft about which the frame can pivot. At the opposite end, the  
15 frame is attached to the skate via a swingarm. Wheel travel and rebound is controlled by a coil over shock reminiscent of skate above wherein each wheel was independently suspended. Here, the skate frame is manufactured by cutting two identically shaped pieces from  
20 a blank of 0.125 in. cold rolled steel to make each of the two skate frame sides (the inboard and outboard sides). Many possible shapes for the frame sides can be employed. Holes for wheel mounting, swingarm attachment, and the shaft are then drilled using an appropriate drill bit in  
25 each frame side. The pieces are then deburred and sanded. Optionally, one or more connectors may then be welded so as to space the frame sides opposite and parallel one another. If employed, these connectors must be placed so as to not interfere with wheel rotation or suspension  
30 movement.

The swingarm in this instance consists of two opposite and parallel spaced arms between which a spring and damper assembly lower mount is welded. Depending the particular configuration employed, the distance between  
35 the arms of the swingarm will vary. In this example, the arms are spaced such that movement of the swingarm is not impinged by the axle bolt of the wheel positioned at the front of the skate frame. The swingarm is then movably

mounted to the skate frame with suitable hardware. A spring and damper assembly is then attached to the swingarm. The skate frame is then attached to the footplate (manufactured to accept this skate frame configuration) using a pivot shaft and swingarm shaft retained with appropriate an combination of hardware, e.g., a threaded nut and two Teflon bushings in the case of a threaded shaft. The spring and damper assembly is then mounted to its corresponding mounting point on the skate frame. Four 76 mm wheels are then mounted to the skate frame, completing the skate.

As will be appreciated, this suspension configuration provides for a decreasing amount of frame and wheel travel, with the wheel furthest from the pivot shaft having the greatest amount of potential travel, and that nearest the pivot shaft the least. However, such a skate suspension system will afford a smoother ride over imperfect skating surfaces as compared to conventional in-line roller skates. Also, mounting the swingarm as depicted, such that its footplate mounting point is positioned behind the front part of the skate frame when viewed from the side, minimizes the potential for impacting the swingarm with obstacles on the skating surface, which could damage the swingarm and/or cause loss of skate control.

ii. Skate with frame suspended by two swingarms.

The skate described herein is similar that described in Example 2, part (B)(i), above, except that a second swingarm is used to attach the skate frame to the footplate. The second swingarm is mounted to the rear of the first in the opposite orientation, i.e., looking at the skate from the side, the footplate mounting point is nearer the front of the skate than the point of swingarm attachment to the skate frame. A spring and damper assembly is again used with the second swingarm.

Because this skate has two swingarms, each of which rotates in an arc the radius of which is determined by the

distance between the centers of the shaft used to attach the swingarm to the footplate and the bolts used to attach the swingarm to the frame and which is opposite that of the other, the sides of at least one end of the skate frame must be slotted to allow the lateral translation of the corresponding swingarm as the suspension reacts vertically to imperfections in the skating surface.

As is evident, this fully suspended in-line skate will afford superior riding characteristics and skate control as compared to conventional in-line skates. In addition, skates employing a suspended skate frame may take advantage on one or more "after market" products designed for the conventional, non-suspended in-line roller skates. Alternatively, accessories may be designed specifically for the skates of this invention. Such accessories include those described below in Examples 3 and 4 ("grind" plates and brakes, respectively).

### Example 3

20

#### *Skate Protectors for In-Line Skates with Wheel Carriage Suspension*

As those in the art will no doubt appreciate, the wheel carriage suspension described above can significantly increase the area on the underside of a skate which can be used for stunt skating, as the center wheels will retract upon contact with various surfaces. Skate protectors can be designed and manufactured to protect the footplate and/or skate frame of in-line skates using a rocker assembly-based suspension. Similarly, skate protectors can also be employed to protect the footplates and/or skate frames of in-line roller skates according to the invention having a swingarm actuated suspension.

For example, an in-line skate frame protector for use in protecting the skate frame of skate having wheel carriage suspension as described in Example 1, above, is

manufactured as follows: A two dimensional template of skate frame protector is drawn on a CAD-CAM computer. This information is then fed into an appropriate computer controlled cutter which cuts multiple pieces of the  
5 specified shape from a piece of 0.125 inch cold rolled steel. Four mounting holes are then drilled in each piece of material, after which it is deburred and sanded.

A mold of the skate frame protector is generated. This mold is then placed in an appropriate cold stamping  
10 press and the flat, cut, drilled skate frame protector stock is stamped into a contoured skate frame protector. These skate frame protectors are then mounted to the frames of skates as described in Example 1, the frames of which have been drilled and tapped to accept the skate  
15 frame protectors. After fitting the skate frame protectors, the in-line skates can be effectively used for performing "street style" skating maneuvers, many of which subject skate frames to a variety of impacts and contacts with abrasive surfaces. Such activities can substantially  
20 reduce the useful life of a particular skate frame in the absence of a skate frame protector.

#### Example 4

##### 25 *Brakes for In-Line Skates with Wheel Carriage Suspension*

Among the many advantages afforded by an in-line roller skate having a rocker assembly suspension as described in Example 1 is that new braking systems may be  
30 developed. Two such brake systems are described below. The first brake system engages the two wheels of the rear rocker assembly of a skate employing two such assemblies, as depicted in Figure 7. The second brake system employs that of the first, in combination with a portion that  
35 engages the skating surface.

i. Two wheel brake.

A brake for engaging two wheels of a four wheel in-line roller skate having two wheel carriage assemblies is constructed by fabricating the brake lever from two brake elements made from cold rolled steel 0.125 in. in thickness and 0.5 in. wide and welded to a steel bushing. The first brake element (16) is of a length such that it will extend from the steel bushing (3) to a point below the area of the third wheel that will be engaged thereby during braking action. To increasing efficiency, a bend having an arc corresponding to that at the wheel's surface is introduced into the first brake element. The second brake element (17) is of a length appropriate to extend from the steel bushing surrounding the threaded coupling (2) to an area behind and below the heel of the boot. A bend is introduced into second brake element approximately 0.5 in. from the end to be welded to the steel bushing. In order to increase effectiveness of the brake and minimize wheel wear, the first and second brake elements can also be fabricated to incorporate an arc or contour at the region of wheel engagement, wherein the arc corresponds to that of the wheel.

The steel bushing and the two brake elements are then welded together in a jig designed to provide the correct obtuse angle between the first and second brake elements so that when attached to a skate and activated by the rider lifting the toe of the skate, both elements will engage their corresponding wheel. The brake is then fitted to the skate by replacing the existing steel bushing of the rear rocker assembly. A spring to return the brake to a resting position after braking can also be included.

The brake is actuated by a rider lifting the toe of the skate. The amount of braking pressure applied is dictated by how far the rider lifts the toe of the skate. As compared to existing in-line skate brakes where only the rear-most wheel remains in contact with the skating surface during braking, both wheels of the rear rocker

assembly of the skate described in this example remain in contact with the skating surface, providing for greater skate control while braking.

To minimize brake-related wear to the wheels engaged  
5 by the brake system above, the two brake elements can be manufactured to accept detachable brake pads. Such brake pads are comprised material designed to wear under braking, thereby decreasing the rate at which the wheels engaged by the brake will wear. Preferably, the brake  
10 pads will also shaped, or "contoured," so as to engage a significant wheel surface area upon brake application. After reaching a minimum thickness, the brake pads are replaced. One way in which to indicate wear of the brake pads is to employ a laminate of one or more materials of  
15 different colors. For instance, the braking surface (outer layer) of new brake pads is a dark color. Replacement is indicated upon exposing a lower layer of a different color.

An in-line skate brake similar to that described  
20 above can also be manufactured for a rocker assembly mounted at the front of the skate. Such a front brake is actuated by lifting the heel of the skate, while keeping the front of the skate in contact with the skating surface. Here, the toe of the skate engages the brake,  
25 with the amount of braking force applied being dependent upon the pressure applied to the brake by the skate. In-line skates according to the invention can be equipped with such a brake at both the front and rear. Alternatively, one skate of a pair of skates may have such  
30 a brake mechanism incorporated into the rocker assembly, whereas the other member of the skate pair has a brake mounted to the rear rocker assembly. Such configurations allow a skater using in-line skates so equipped to brake from a variety of positions. Maximum braking, wherein a  
35 brake from on each skate is engaged, can be accomplished when the skater positions one skate farther forward than the other skate. The skater then lifts the toe of the forward most skate, actuating its rear brake, and lifts

the heel of the other skate to engage its front brake. Such a braking position can increase the skater's directional stability under braking, and because four wheels are exposed to braking forces while at the same time maintaining contact with the skating surface, stopping distances can be reduced.

ii. In-line skate equipped with multiple brakes.

In-line roller skates as described in part (i) above can also include a conventional rear mounted brake to further enhance braking power. For instance, a brake similar to a brake that mounts to the back of a skate boot can also be included. When a skater tilts rearward a skate so equipped, the wheel braking system incorporated into the rear rocker assembly is actuated, as is the conventional brake to slow the skater.

While the present invention has been described in terms of its preferred embodiments, it is understood that variations and modifications will occur to those skilled in the art. Therefore, it is intended the appended claims cover all such equivalent variations which come within the scope of the invention as claimed.

Additionally, the publications and other materials cited to illuminate the background of the invention, and, in particular, to provide additional details concerning its practices described in the detailed description and examples, are hereby incorporated by reference in their entirety.

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\* \* \*

WHAT I CLAIM IS:

1. An in-line roller skate with suspension, the skate  
5 comprising:
  - (a) a footplate;
  - (b) a plurality of wheels aligned linearly front to rear;  
and
  - (c) a rocker assembly carrying at least two adjacent  
10 wheels, wherein at least one of the wheels carried thereby  
is capable of moving vertically in a direction opposite  
that of at least one other wheel carried by the rocker  
assembly, wherein the rocker assembly is rotatably  
15 connected to the footplate about an axis parallel to that  
of a wheel axle of a wheel carried by the rocker assembly,  
and wherein a spring and damper assembly is mounted to an  
upper surface of the rocker assembly.
2. An in-line roller skate according to Claim 1 that  
20 comprises at least two rocker assemblies mounted to the  
footplate, wherein each rocker assembly carries at least  
two wheels.
3. An in-line roller skate according to Claim 2 that  
25 comprises two rocker assemblies mounted to a footplate,  
wherein each rocker assembly carries two wheels.
4. An in-line roller skate comprising:
  - (a) a footplate; and
  - 30 (b) a plurality of wheels aligned linearly front to rear  
in a manner such that at least one wheel is capable of  
vertical displacement while the skate is in motion across  
a skating surface, wherein the vertical displacement  
results from rotation of a wheel carriage about an axis  
35 parallel to that of a wheel axle of a wheel carried  
thereby and is controlled by a spring and damper assembly  
attached thereto, wherein the wheel carriage carrying the



vertically displaced wheel is attached directly or indirectly to the footplate.

- 5        5. An in-line roller skate with suspension, the skate comprising:
- (a) a footplate;
  - (b) at least one skate frame attached to the footplate;
  - (c) a plurality of wheels aligned linearly front to rear with all wheels being mounted to the skate frame(s); and
  - 10        (d) a rocker assembly carrying at least two adjacent wheels, wherein the rocker assembly is rotatably connected about an axis parallel to that of a wheel axle of a wheel to the skate frame and enables at least one of the wheels carried thereby to move vertically in a direction opposite
  - 15        that of at least one other wheel carried by the rocker assembly.
- 20        6. An in-line roller skate according to Claim 5 that comprises one skate frame and at least two rocker assemblies mounted to the skate frame, wherein each rocker assembly carries at least two wheels.
- 25        7. An in-line roller skate according to Claim 6 wherein at least one rocker assembly comprises a spring and damper assembly.
- 30        8. An in-line roller skate according to Claim 7 wherein the spring and damper assembly comprises at least one elastomeric polymer mounted to an upper surface of the rocker assembly.
- 35        9. An in-line roller skate with suspension, the skate comprising:
- (a) a footplate;
  - (b) a skate frame attached to the footplate;
  - (c) four wheels aligned linearly front to rear; and
  - (d) two rocker assemblies, each rocker assembly carrying two of the wheels and having a spring and damper assembly

mounted to an upper surface thereof, wherein each rocker assembly is rotatably connected about an axis parallel to that of a wheel axle of a wheel to the skate frame such that one wheel carried thereby is capable of moving  
5 vertically in a direction opposite that of the other wheel carried by the rocker assembly.

10. An in-line roller skate according to Claim 6 that comprises two rocker assemblies mounted to the skate  
10 frame, wherein each rocker assembly carries two wheels.

11. An in-line roller skate comprising:  
(a) a footplate;  
(b) at least one skate frame attached to the footplate;  
15 and  
(c) a plurality of wheels aligned linearly front to rear with all the wheels being mounted to the skate frame(s) in a manner such that at least one wheel is capable of vertical displacement while the skate is in motion across  
20 a skating surface, wherein the vertical displacement results from rotation about an axis parallel to that of a wheel axle of a wheel carried by a wheel carriage carrying the vertically displaced wheel, wherein the skate frame is attached directly or indirectly to the footplate.

25 12. An in-line roller skate according to Claim 4 wherein at least one wheel is capable of a vertical displacement of greater than about 0.05 inch while the skate is in motion across a skating surface.

30 13. An in-line roller skate according to Claim 4 wherein at least one wheel is capable of a vertical displacement of greater than about 0.10 inch while the skate is in motion across a skating surface.

35 14. An in-line roller skate according to Claim 4 wherein at least one wheel is capable of a vertical displacement

of greater than about 0.125 inch while the skate is in motion across a skating surface.

15. An in-line roller skate according to Claim 4 wherein  
5 all of the wheels are capable of vertical displacement while the skate is in motion across a skating surface.

16. An in-line roller skate according to Claim 15 wherein  
10 each wheel is independently suspended from the footplate by a swingarm assembly.

17. An in-line roller skate according to Claim 16 wherein  
each swingarm assembly further comprises a spring and  
damper assembly.

18. An in-line roller skate according to Claim 4 wherein  
all of the wheels are carried in a skate frame suspended  
from the footplate by at least one swingarm assembly.

19. An in-line roller skate according to Claim 18 wherein  
20 each swingarm assembly further comprises a spring and damper assembly to control vertical displacement of each swingarm.

20. An in-line roller skate according to Claim 11 wherein  
25 all of the wheels are carried in a skate frame suspended from the footplate by at least one swingarm assembly.

21. An in-line roller skate according to Claim 20 wherein  
30 all wheels are carried in a skate frame having a front end and a rear end, wherein the skate frame is suspended from the footplate by a swingarm assembly positioned to the front end of the skate frame, and wherein the rear end of the skate frame is rotatably attached to the footplate.

22. An in-line roller skate according to Claim 15 wherein  
35 all wheels are carried in a skate frame suspended from the footplate by two swingarm assemblies.

23. An in-line roller skate according to Claim 22 further comprising a spring and damper assembly to control vertical displacement of each swingarm.

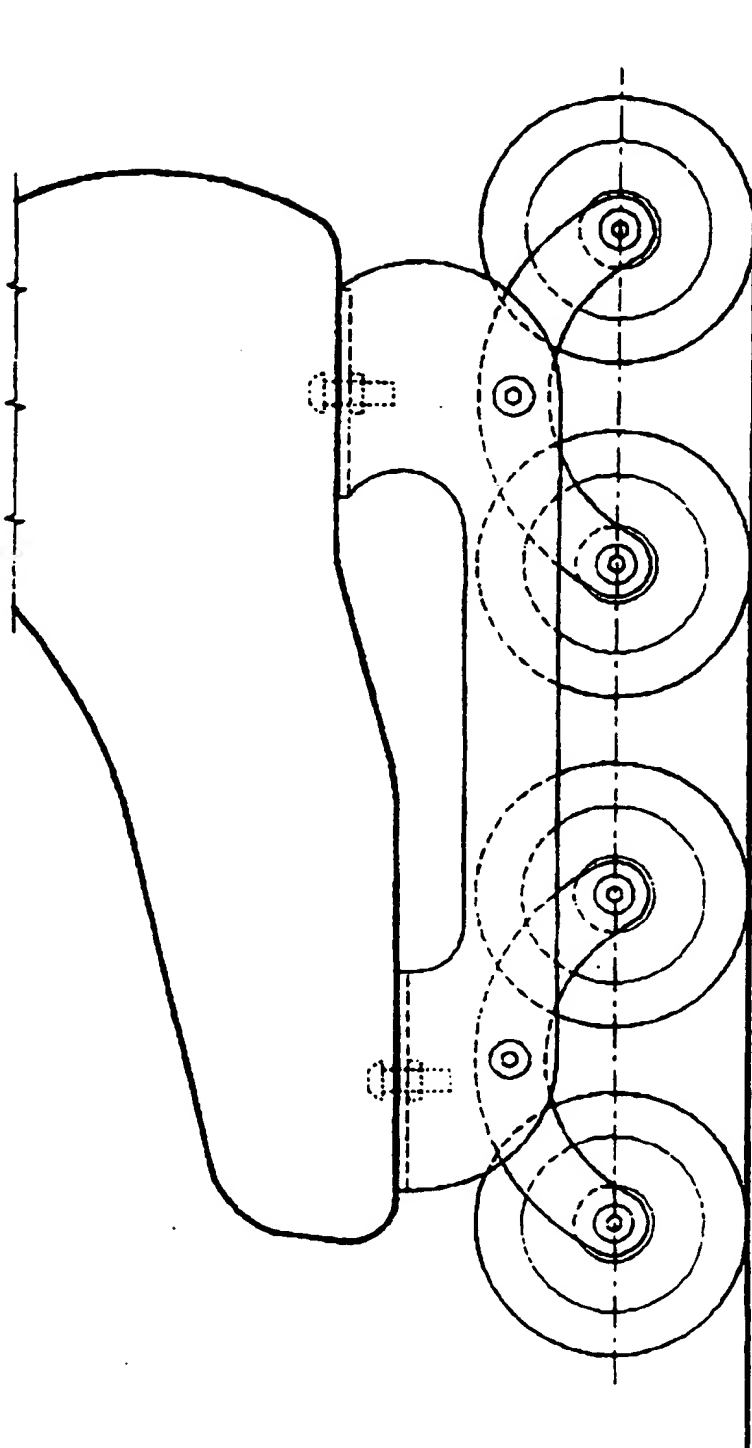
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24. An in-line roller skate according to Claim 5 further comprising a brake system.

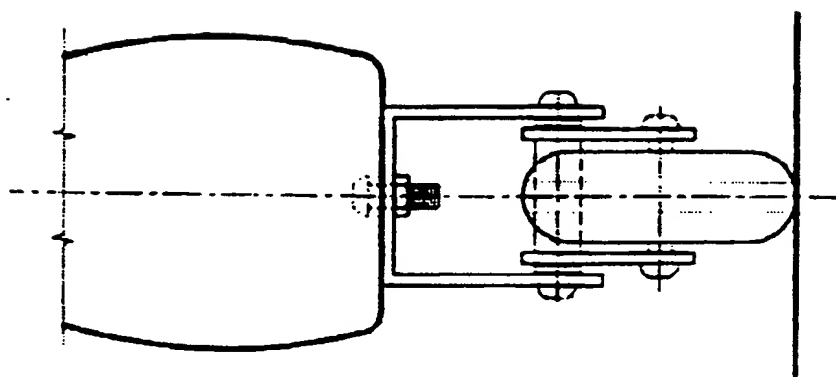
25. An in-line roller skate according to Claim 24 wherein the brake system comprises a brake pad mounted the skate frame.

26. An in-line roller skate according to Claim 1 wherein at least one wheel can rotate about an axis perpendicular to its axle.

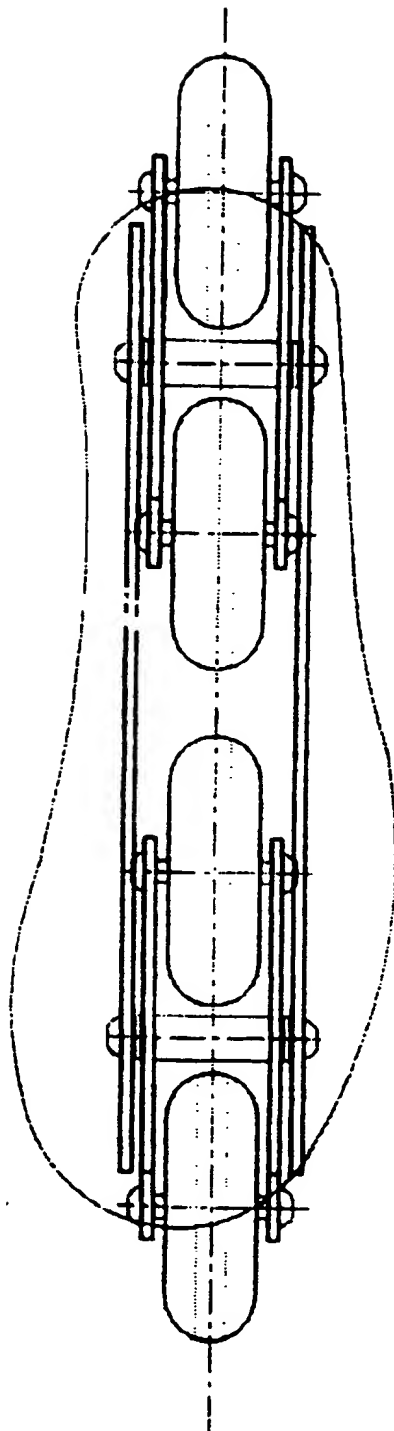
27. An in-line roller skate according to Claim 11 to which a skate frame protector has been attached, the protector comprising at least one vertical element which extends below an underside of at least a portion of the skate frame to which the protector is attached.



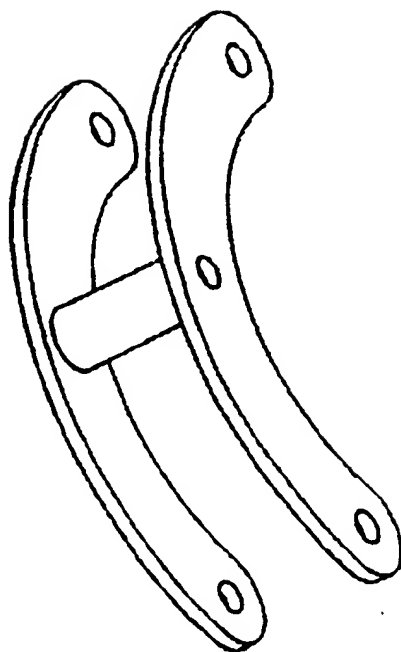
**Figure 1**



*Figure 2*

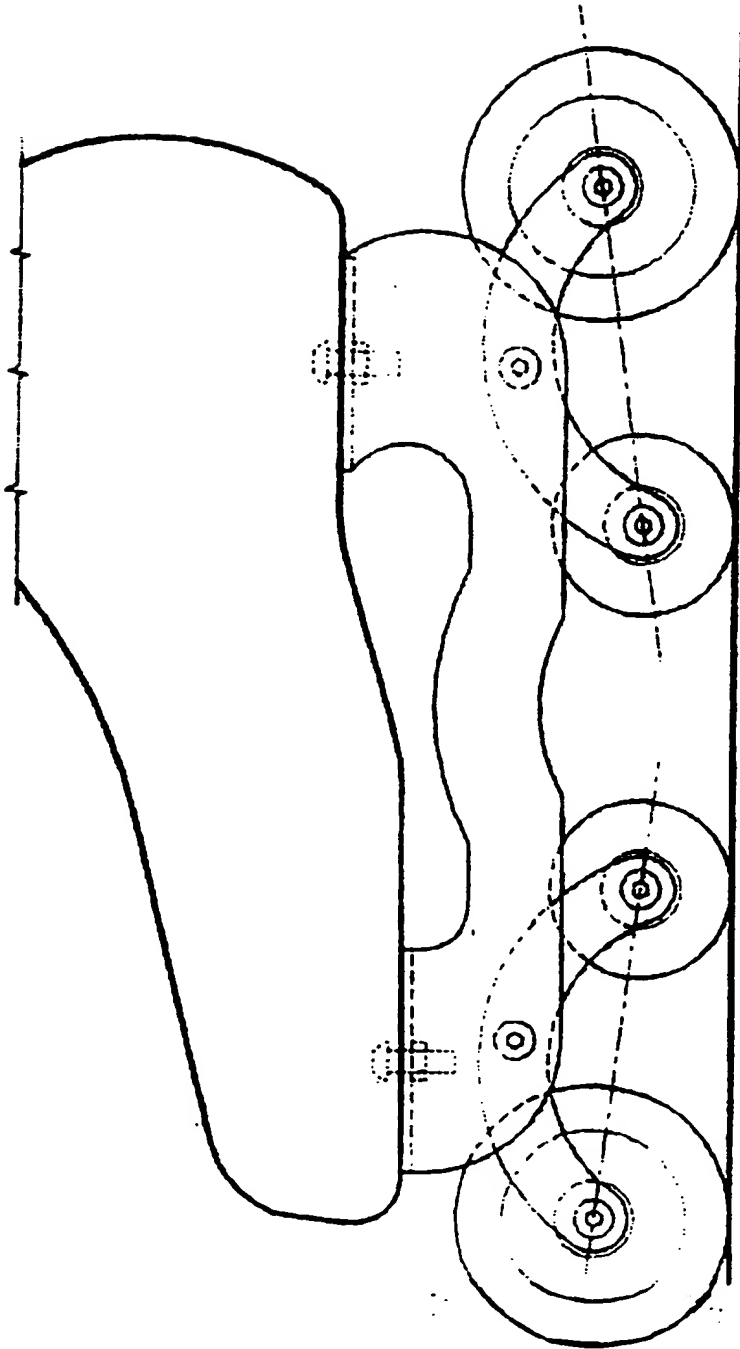


*Figure 3*

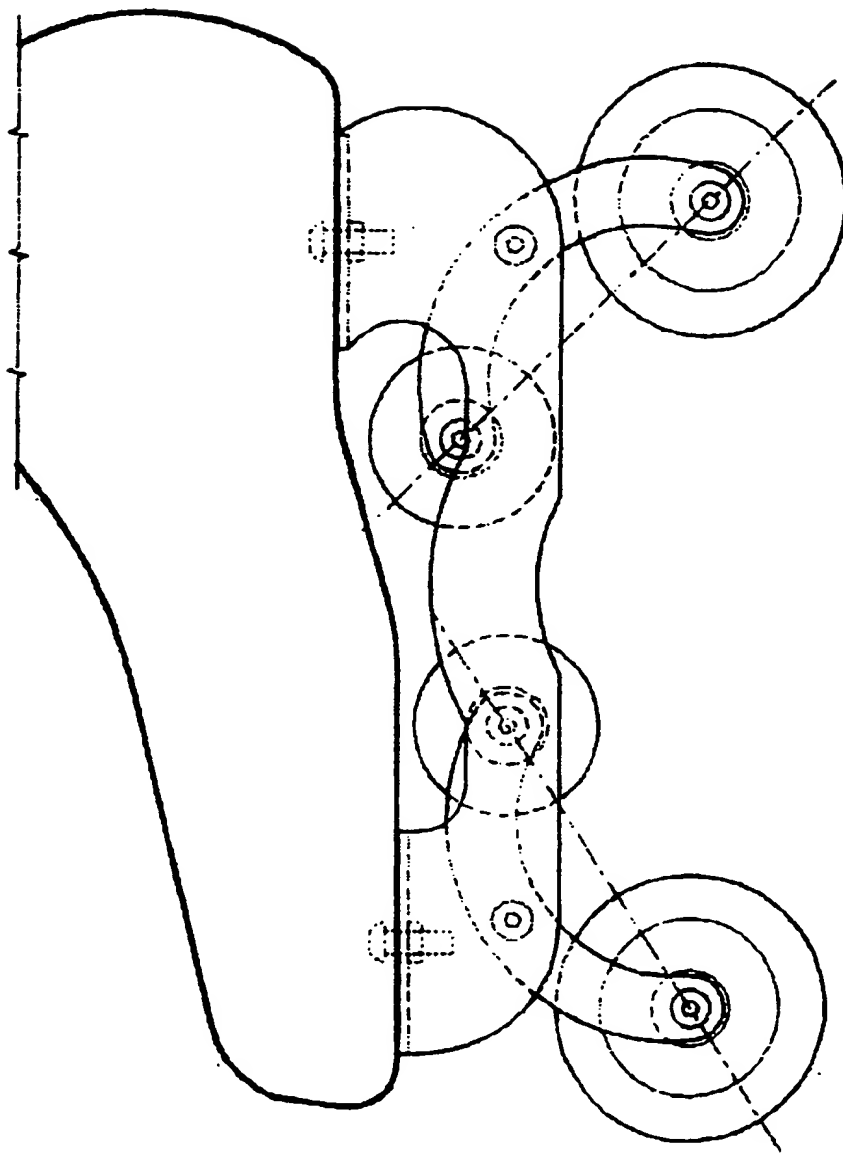


**Figure 4**



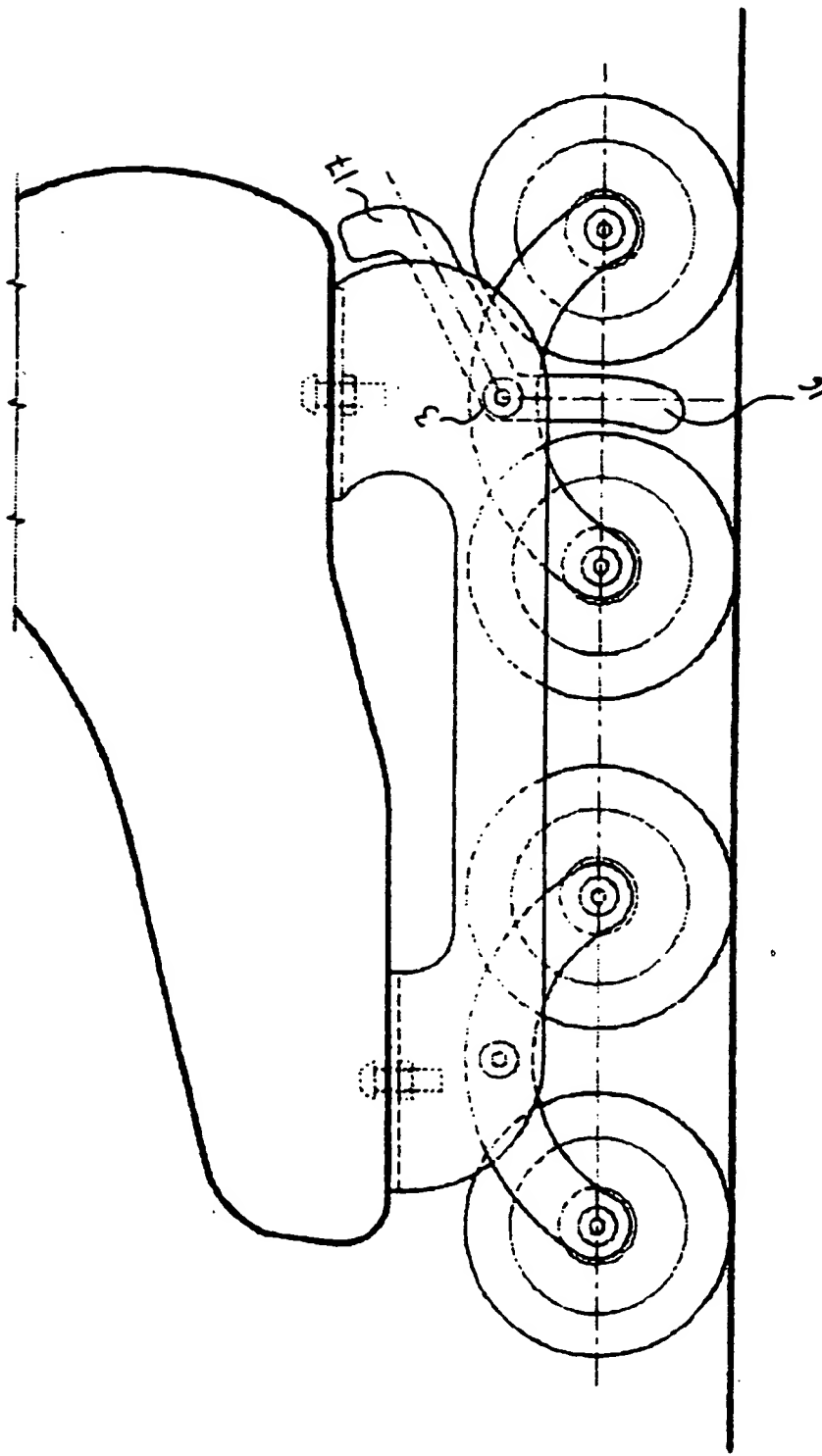


**Figure 5**



**Figure 6**

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**Figure 7**

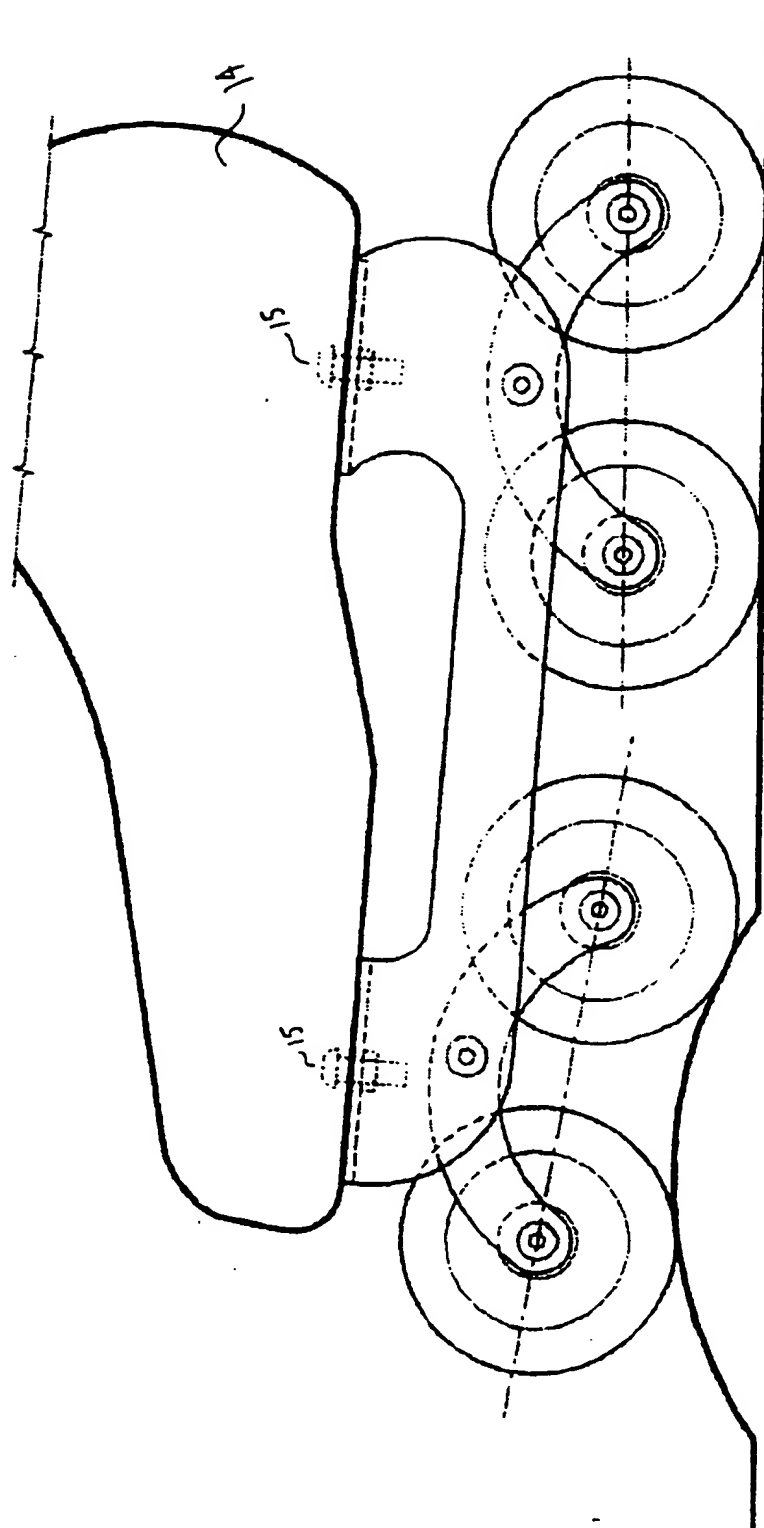
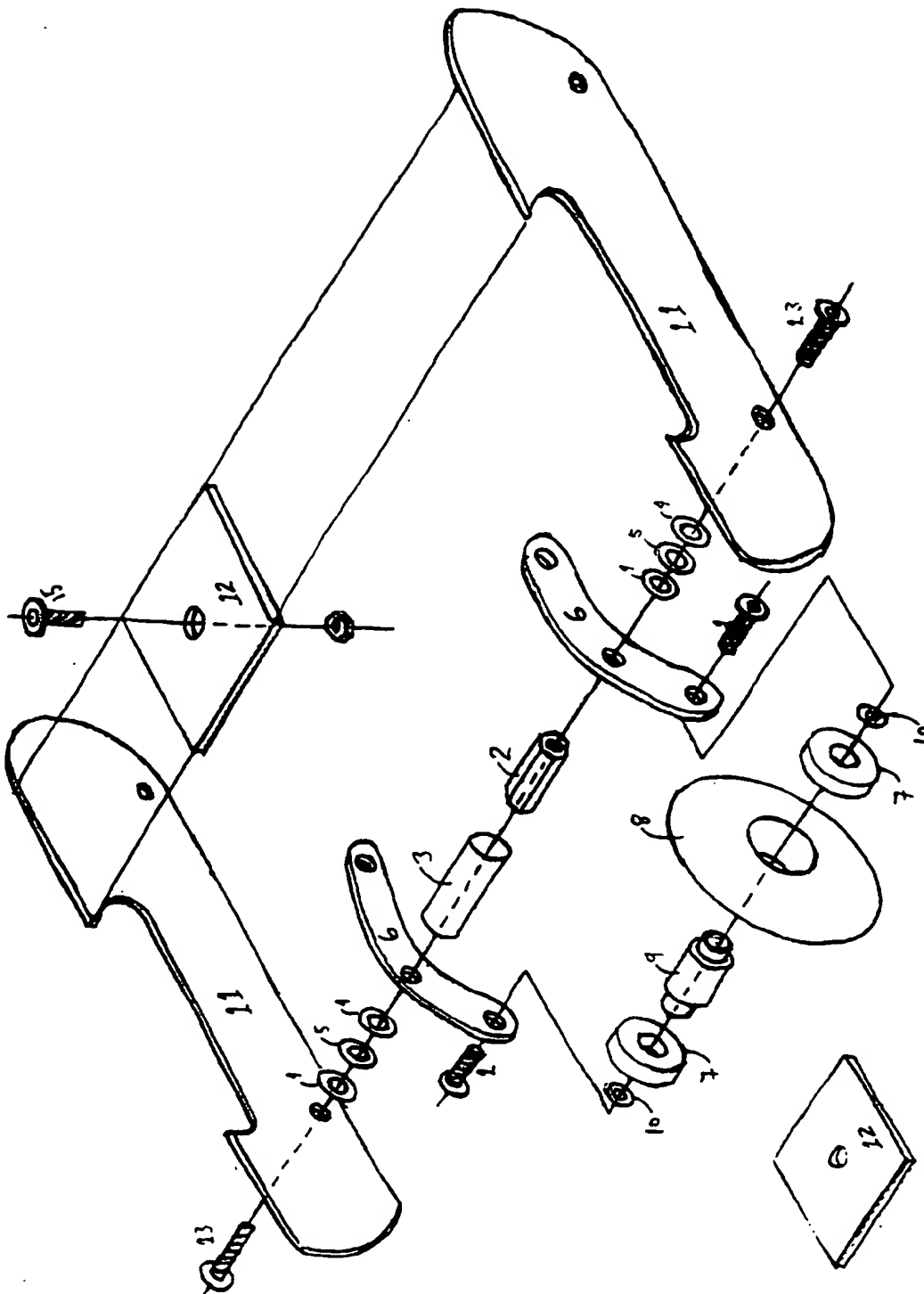
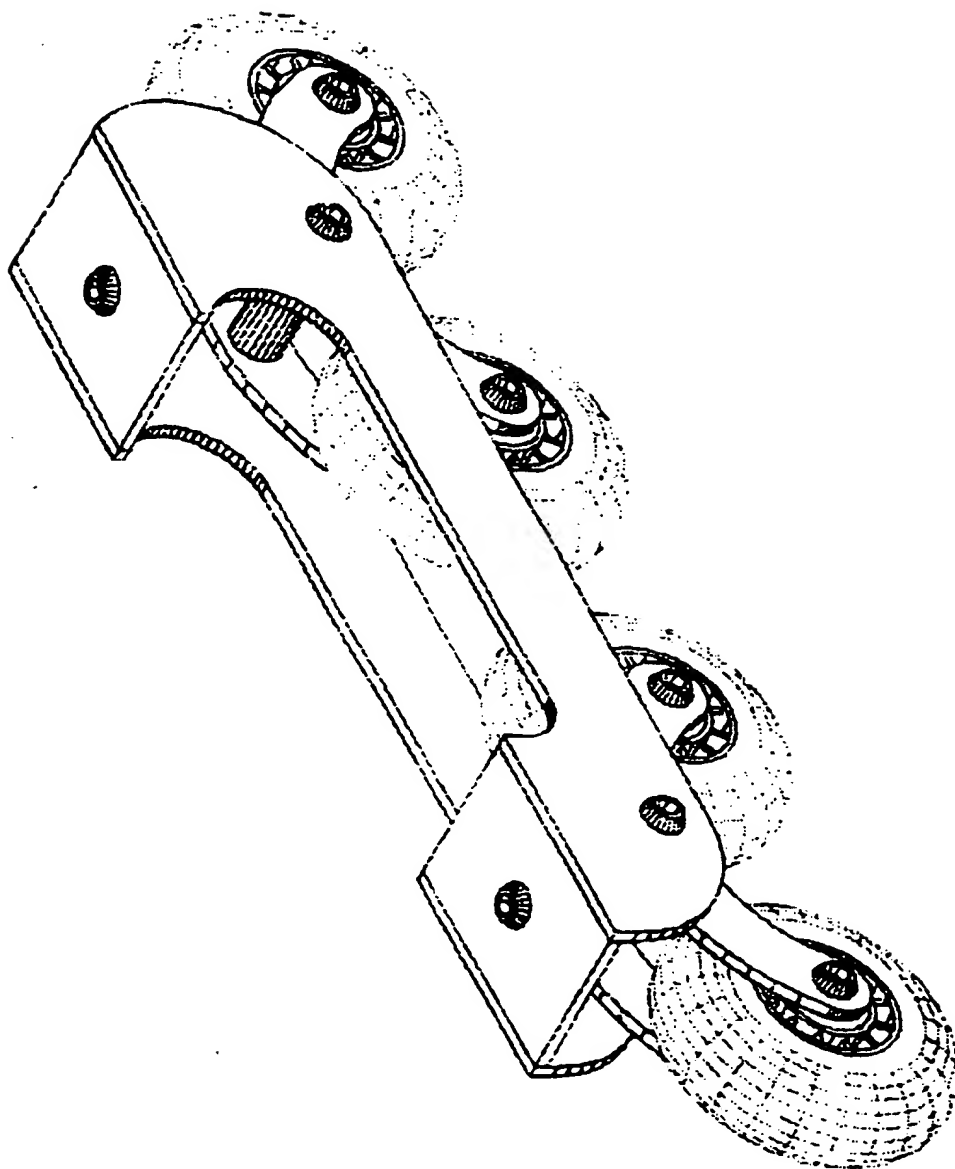


Figure 8



**Figure 9**



**Figure 10**